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USER DIAGNOSTIC TO DETECT SECONDARY INK PUMP DEGRADATION

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User diagnostic to detect secondary ink pump degradation

Abstract

Some Recirculation Ink Delivery System requires the intra printhead ink recirculation, also referred to as minor-recirculation, to maintain the dispersion of inks with large solids, such as, but not limited to, white ink.

Minor-recirculation is activated by applying positive pressure in one of the printhead needles, negative pressure in the other printhead needle and opening the printhead bag regulator through a controlled blow prime. Thus, when using a single color printhead with a fluidic connection between the printhead slots, the ink can flow from positive to negative pressure.

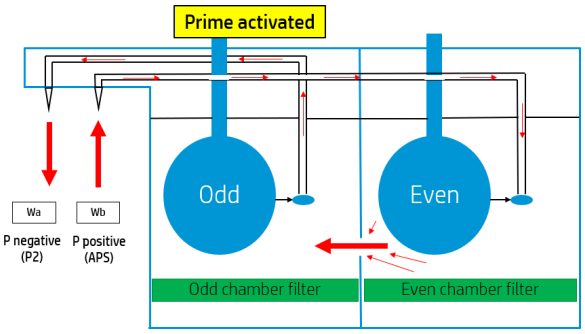

Figure 1. Minor-Recirculation operation

The minor-recirculation involves several subsystems: the primer assembly, the Air Pressure System (APS), the secondary ink pump and the printhead itself. Thus, if an issue during the minor-recirculation happens, it may be difficult to detect the failing component. In particular, in the case of a volumetric secondary ink pump driven by three rat tails, its troubleshooting, could be difficult if the defect is not visible, for example in the case of the wear out of the rat tail.

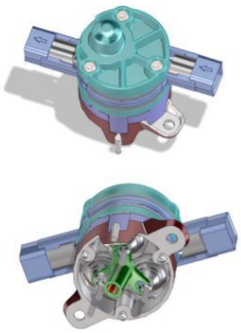

Figure 2. MALT ink pump

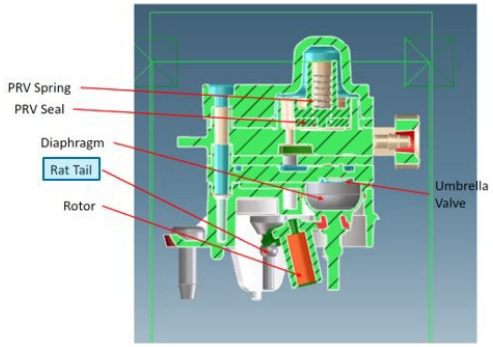

Figure 3. Pump anatomy. Rat tail identification.

Figure 4. Image of one of the rat tails of a secondary ink pump showing low vacuum capacity due to the wear out.

The invention proposed is a user diagnostic to detect a malfunction on the secondary ink pump related to a wear out of the rat tail, leading to not generating enough vacuum pressure which leads to a low-flowrate and/or false printhead blockage events.

Invention

Monitoring the ink pump consumption during the minor-recirculation to detect a malfunction on the secondary ink pump may be useful to detect the case of a piston dislodged, which would impact on the profile of the ink pump consumption (less smooth). However, it would not detect the case of issues related to wear out of the rat tails.

The invention proposed monitoring the ink pump consumption during a certain routine (*pump flowrate degraded recovery process*).

In the first phase of this routine, the outlet of the secondary ink pump is closed using the electro-valves and the inlet is connected to the Intermediate Tank, which is pressurized at a certain pressure, typically 1 Psi. Then, the secondary ink pump is turned on at a considerable rpms (higher than during the minor-recirculation) and the ink pressure considerably increases since the outlet is closed.

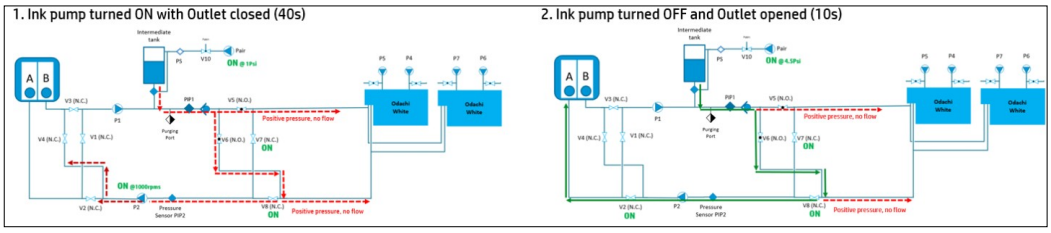

Figure 5. Pump flowrate degraded recovery process

If there is a wear out of the rat tail during this process, the ink pump consumption is considerably reduced since the degradation of the ink pump implies that the pump generates a lower positive pressure thus, reducing its consumption when set at a certain rpm.

Since a degradation on the rat tail implies not only a reduction on the capability of the ink pump to generate positive pressure, but also to generate vacuum pressure, by detecting this condition during the process, it can be correlated to a malfunction during the minor-recirculation, when the ink pump is turned on to generate vacuum pressure.

The user diagnostic consist of three phases:

1. A refill of the Intermediate Tank is performed. Ensuring that there is enough ink to perform the process, as well as having a well-known condition of the Intermediate Tank level.
2. The pump 11 recovery process is performed, and the secondary ink pump is monitored. If the pump consumption is lower than a certain threshold, the ink pump is marked as potentially affected by wear out of the rat rail pistons.
3. A minor-recirculation through the printhead is triggered. During this process, the flowrate is monitored based on the APS profile, as well as detecting a printhead blockage conditions.

If the secondary ink pump is detected as degraded during the second phase, and during the third phase the flowrate is low or a printhead blockage event occurs, a message indicating that the secondary ink pump needs to be replaced is sent to the customer.

The following examples compare the user diagnostic with a healthy secondary ink pump (figure 6) and with a secondary ink pump affected by wear out (figure 7).

- **Healthy ink pump:** during the second phase, the ink pump consumption is around 6V and during the third phase, the flowrate to the printhead is as expected based on the APS profile.

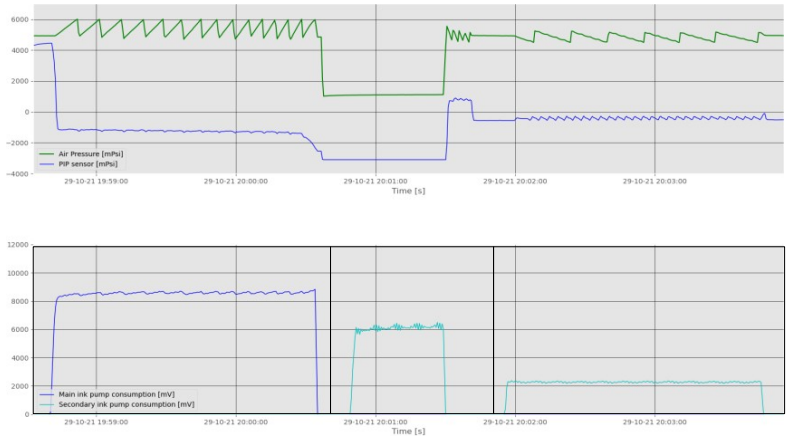

Figure 6. User diagnostic with a healthy ink pump

- **Ink pump affected by wear out:** during the second phase, the ink pump consumption is lower than the threshold, setting the ink pump as potentially affected by wear out. During the third phase, it is required 5x attempts until detecting ink flow through the printhead. Then, the flow is quite low based on the APS profile (slope).
  Note: in this test, the threshold required to detect flow was reduced to see capture the APS profile and secondary ink pump consumption during a minor-recirculation when the ink pump is affected by wear out.

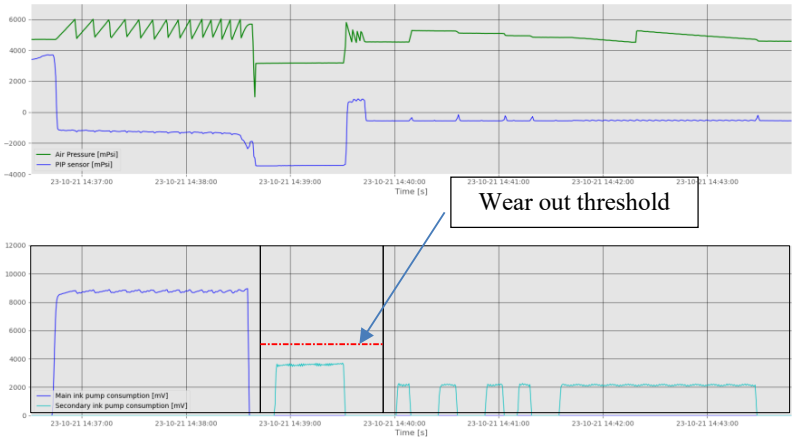

Figure 7. User diagnostic with an ink pump affected by wear out

The advantages that provides the invention are:

- Diagnosability: the diagnostic allows to verify a malfunction on the secondary ink pump related to a wear out of the rat rail of the piston.
- Customer experience: allowing the customer to self-diagnose the secondary ink pump increases the overall experience.

- Troubleshooting: having a dedicated diagnostic to troubleshoot the secondary ink pump helps the Service Engineer team to correctly replace the affected parts.
- Repair cost: in some cases, the Service Engineer replaces several parts until the error disappears, but this may lead to replace parts that are working properly. The diagnostic helps to replace the ink pump if it is affected by wear out.
- Automatic process: an automatic diagnostic can also be implemented during the normal operation of the printer. In fact, in Polestar and Sunspot printers, the *pump flowrate degraded recovery process* is performed preventively after the major-recirculation to avoid other issues, and afterwards a minor-recirculation is performed. If the White printheads are installed, the same detection proposed as a user diagnostic can be performed at that point.
- Cost: It reuses the current hardware of the printer and no additional electronic element (EE board, cables…) or mechanical parts are required.

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